



Union of South Africa

DEPARTMENT OF COMMERCE AND INDUSTRIES

DIVISION OF FISHERIES

INVESTIGATIONAL REPORT No. 33.

THE SOUTH AFRICAN PILCHARD

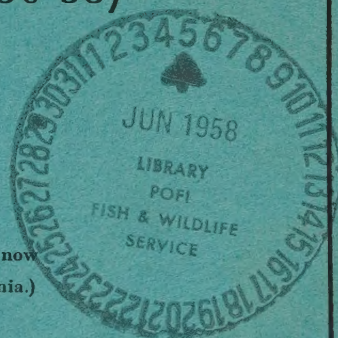
(*Sardinops ocellata*)

PRELIMINARY REPORT ON THE
AGE COMPOSITION OF THE
COMMERCIAL CATCHES, (1950-55)

BY

D. H. DAVIES, M.Sc., Ph.D.

(Senior Professional Officer, Division of Fisheries, now
Institute of Marine Resources, University of California.)



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I.—SUMMARY.

This is a further paper in a series dealing with the general biology of the South African pilchard, *Sardinops ocellata* (Pappé), and is a preliminary report on the age composition of the commercial catches of pilchards made off the West coast of the Union of South Africa during the years 1950–55.

The introduction is followed by a brief description of the method used for the reading of the scales, after which some consideration is given to the type, formation and incidence of rings on pilchard scales and their significance in relation to the age of the fish. There follows a section dealing with the age of the pilchards comprising the commercial catches and a further section dealing with their rate of growth.

It is stressed that this report is of a preliminary nature written with the main object of providing basic information concerning the age of the commercially-fished pilchard population of the West coast. Certain of the findings are therefore of a tentative nature and need confirmation.

Based on the examination of scales from 1,423 fish, the findings resulting from this investigation are briefly as follows:—

- (1) It appears that two rings are formed on the scales of pilchards each year.
- (2) The formation of these rings is not directly related to either annual growth or spawning but to sharp changes in the condition of the fish.
- (3) The two rings are of different types, one being clear and well-formed and the other rather indistinct.
- (4) The first type is formed in *autumn* when a sharp *decline* in the condition, as indicated by the condition factor, occurs. The second type is formed in *spring* when a steep *rise* in condition factor takes place.
- (5) During the period 1950–55 the age of male and female pilchards caught in the commercial catches ranged from two to eight-year old fish. *The majority of pilchards caught fell within the age groups from three to seven years.*
- (6) A study of the rate of growth of male and female pilchards has shown that the female is larger than the male.

- (7) A comparison of the rate of growth of the South African pilchard with that of closely related species from other parts of the world has shown that although generally slower than that of the California sardine its rate of growth is more rapid than that of the European pilchard off Britain, the Japanese pilchard and the Australian pilchard in the waters of New South Wales.

2.—INTRODUCTION.

This report is the eighteenth in a series dealing with the general biology of the South African pilchard and its environment.

The pilchard is distributed over a wide range of more than 2,000 miles from Angola off the West coast to Durban off the East coast. Large concentrations of pilchards occur at Baia dos Tigres off Angola, Walvis Bay off South West Africa, and the St. Helena Bay-Saldanha Bay area off the West coast of the Union of South Africa. Commercial exploitation takes place at an average annual rate of 25,000 tons off Angola, 250,000 tons off South West Africa and 135,000 tons off the West coast of the Union of South Africa. Pilchard shoals migrate up the East coast of the Union, in the month of June each year and small numbers (up to 25 tons a year) are caught by local fishermen.

In a previous report the author (Davies, 1957) made a general assessment of the size composition of the commercial catches of pilchards off the West coast of the Union of South Africa for the period 1950–55. In this report an attempt is made to provide basic information concerning the age composition of these catches. The report is, however, of a preliminary nature and its main object is the immediate provision of as much information as possible with the material at present available. Certain of the findings are tentative and will need confirmation after a more detailed treatment and assessment of the data and an examination of additional material have been carried out. It is a further object of this report to stimulate a thorough revision of the present methods used in the age determination of the South African pilchard and the introduction of further extensions and modifications of these investigations.

As far as is known no attempt to assess the age of the South African pilchard had been made prior to 1950. In this year the *Pilchard Research Programme* was started by the Division of Fisheries

with the main objects of investigating the general biology, bionomics and environment of the pilchard. Among the various topics included in the programme was the study of the age composition of the commercial catches of pilchards made off the West coast.

From the beginning of the programme in 1950 until 1953, scales and otoliths were collected at the field laboratories of the two shore stations situated at Lambert's Bay and Stompneusbaai—two localities strategically placed in the commercial fishing area of the West coast. In 1953, however, the northern shore station at Lambert's Bay was closed down and the biologist was transferred to the southerly station. From this time onwards, therefore, the amount of age determination material collected at Stompneus was doubled.

During the years 1950–55, scales and otoliths from a total of 1,423 pilchards were sent to the headquarters laboratories at Sea Point for examination.

3.—METHOD.

The sampling of the commercial catches of pilchards by the biologists stationed at the field laboratories was carried out on a daily basis. Two random samples, each consisting of 50 fish were taken on every day that catches were made. Scales and otoliths were taken from the first three males and the first three female pilchards in the sample. When a fish had no scales or lacked scales in the area of the body from which scales were normally taken, it was discarded and the next one taken.

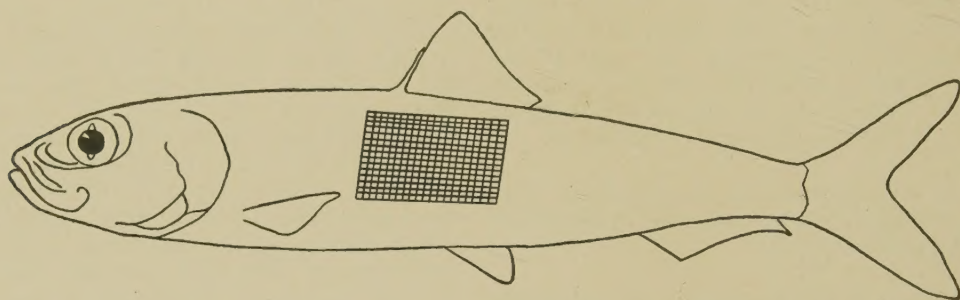


FIG. 1. THE AREA IN WHICH SCALES WERE COLLECTED

At least six scales were taken from every fish. Once removed, they were well rubbed between the fingers and thoroughly washed in cold water. They were then dried on filter paper and placed together with the cleaned otoliths in a small envelope. A sliver of camphor was included in the envelope to prevent the formation of mould. The serial number and particulars of the length, weight, sex, etc., of the fish were written on the envelope and it was then despatched to the headquarters laboratories at Sea Point.

At the start of the programme a series of examinations of scales taken from different areas on the body of the pilchard was made. From these investigations it was concluded that the area on the flank below the dorsal fin and posterior to the pectoral fin was by far the most suitable for the collection of scales for purposes of age determination. This area is clearly shown (see fig. 1). In

this area scales tended to be large and subject to least distortion. All the scales used in this investigation were collected in this area.

The general technique used in the preparation of scales for mounting, projection and examination was similar to that described by Blackburn (1949). The scales were placed in a 2 per cent solution of sodium peroxide for at least eight hours. They were then removed, dipped in a 2 per cent solution of sodium sulphite and placed on a clean glass slide. The scales were then made to stick to the slide by means of pressure of the fingers on a piece of filter paper. These dry mounts lasted long enough for projection and examination after which they were replaced in envelopes. It was found that the use of Mayer's albumen to stick the scales on the slide tended to obscure the clarity of the scales.

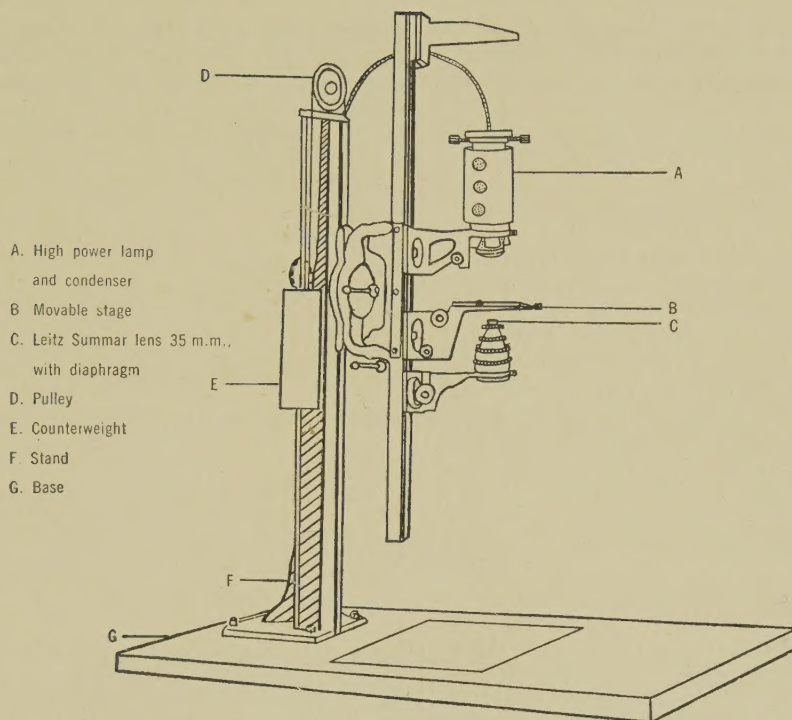


FIG. 2 SCALE-READING APPARATUS

The scales were projected by means of a 35 mm. Summar lens on a projection apparatus model 1926, designed by Leitz after Edinger, illustrated in fig. 2.

This apparatus was used in conjunction with a high-power microscope lamp with condenser and transformer and a movable stage. Four intermediate collars and an adjustable diaphragm were incorporated in the lens assembly and the lamp, stage and lens assembly were all capable of independent, vertical adjustment by means of rack and pinion.

The slide with the scales on it was placed on the movable stage and centred on the first scale. The image of each scale in turn was then directly projected onto a sheet of buff-coloured card at a magnification of approximately 15 diameters. A specially cut piece of paper—white in colour in order to contrast with the buff-coloured card—was laid across the longitudinal axis of the scale image. Marks were then made on the paper beginning with the posterior edge of the sculptured part of

the scale which was marked zero and then at each point where a scale ring or annulus was crossed by the margin of the paper. The scale length between the zero mark and the outermost projection of the sculptured part of the scale along its longitudinal axis was then measured. This was repeated for each of the six scales collected for each fish. The six pieces of paper were then laid on a proportion chart (see fig. 3) in turn and the approximate total lengths of the fish at the time of the formation of each annulus were read. The mean reading at each ring for the six scales was then calculated and entered in a log book together with details concerning the fish such as length, weight, sex, etc.

No reference was made to these particulars before or during the reading of the scale and each complete annulus was counted irrespective of its degree of clarity. During the course of the examination of scales from 1,423 fish used for this investigation the services of six different biologists, including the author, were employed. At no

time, however, were more than two biologists engaged in the reading of scales at any one time and at times only one biologist was available for this work.

Otoliths were taken from the fish from which

scales were removed. A longitudinal incision through the mid-head region was made with a sharp knife and the two otoliths removed with forceps. These were washed, dried and included in the envelopes containing the scales.

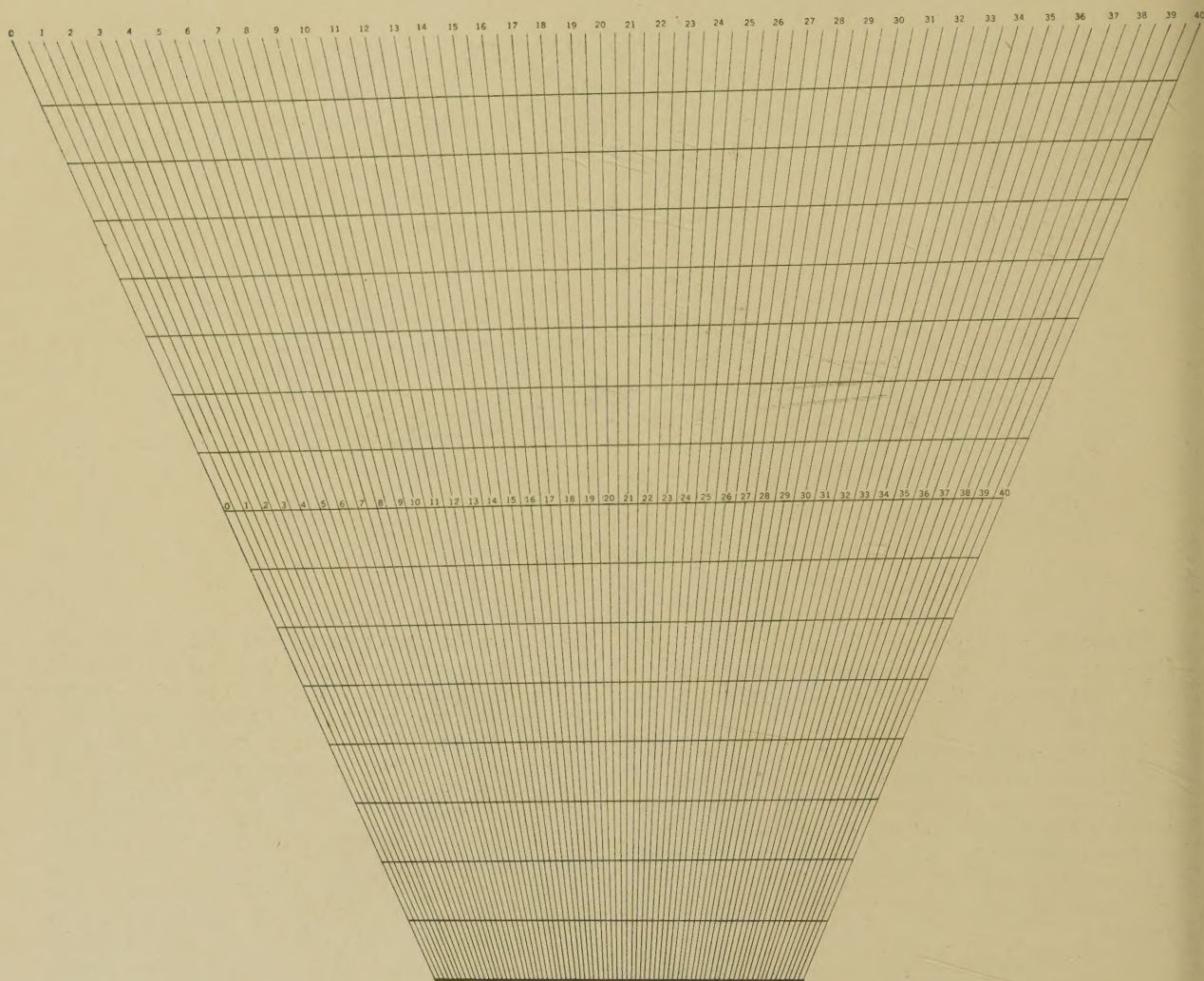


FIG. 3. PROPORTION DIAGRAM FOR OBTAINING INTERMEDIATE LENGTHS.

At the headquarters laboratories, otoliths were placed in sodium peroxide together with the scales and then examined for rings under a dissecting microscope with a dark background, and lighting arranged above and at the side. Reading of the otoliths beyond the three to four ring stages was found to be extremely difficult, due to the fact that rings were so close together and in consequence little use was made of otoliths in these investigations. *There is no doubt, however, that the otolith method of determining the age of the South African pilchard has possibilities and further examination of otoliths together with some modification of the method employed may yield far better results.*

4.—OBSERVATIONS ON THE SCALE-RINGS.

The scale of the South African pilchard is typically clupeid in general form. It is a cycloid scale with the larger, anterior part which is embedded in the skin sharply differentiated from

the posterior, projecting portion. The anterior region is dark and is traversed by numerous fine *striae* which run more or less transversely together with a smaller number of much larger transparent *radii* running transversely. The anterior portion of the scale has a finely sculptured appearance while the posterior part is more or less clear and is generally slightly eroded at the margin.

At the beginning of these investigations it was noted that all the scale-rings on any single scale were not identical in thickness, quality or intensity but it was decided that as little was known at the time about the circumstances of the formation of the various types of rings, every ring should be taken into account and given equal prominence in its possible significance in relation to growth and age. In the examinations of all pilchard scales, therefore, all the complete rings on every scale were considered as being of equal importance and the appropriate length data recorded accordingly.



FIG. 4. SCALE OF PILCHARD SHOWING TWO TYPES OF RINGS DISCUSSED IN SECTION 4.

Later, more detailed examination of individual scales revealed that in the majority of cases, rings were of two distinct types and were formed

according to a definite pattern. The first type of ring was fine and rather indistinct while the second type was clear and well-defined. The latter type

of ring usually stood out well and seldom presented any difficulties of demarcation while the first type was often difficult to distinguish. These two types of rings were laid down in succession and the weak ring was usually followed by the bold ring. An illustration of this succession in the formation of the two types of rings on the scale of the pilchard may be clearly seen in the photograph of a typical scale (see fig. 4).

While the opinion held by some authors that an annulus is formed on the scale at the end of a year of growth and that a second ring is formed at every spawning, has a strong appeal, there appears to be no explanation for the formation of rings on the scales of the South African pilchard at these times.

Examination of pilchard scales in relation to the seasonal variation of the condition factor of the fish was more encouraging.

The mean condition factor (K) for all size-groups of pilchards encountered in the commercial catches was calculated for each month of the year 1953,

using the formula $K = \frac{100w}{l^3}$ when w = the weight and l = length of the fish. The mean oil content of the commercial catches of pilchards was obtained from the factory returns for the same year (Davies, 1956) and plotted together with the condition factor (see fig. 5).

From these graphs it is evident that considerable variation in condition factor takes place during the year. This variation in condition factor is to some extent followed by the oil yield. In general, condition factor is high in summer, reaches a maximum in March, declines rapidly in autumn and winter through to September and then rises sharply in spring. The values of K for male and female pilchards show an almost identical variation. The figures for condition factor for the month of November are based on very small numbers of fish which consisted mainly of smaller size-groups. The position of the graph of condition factor for this month is almost certainly incorrect and there is probably a steady increase in K from October through November and December to January.

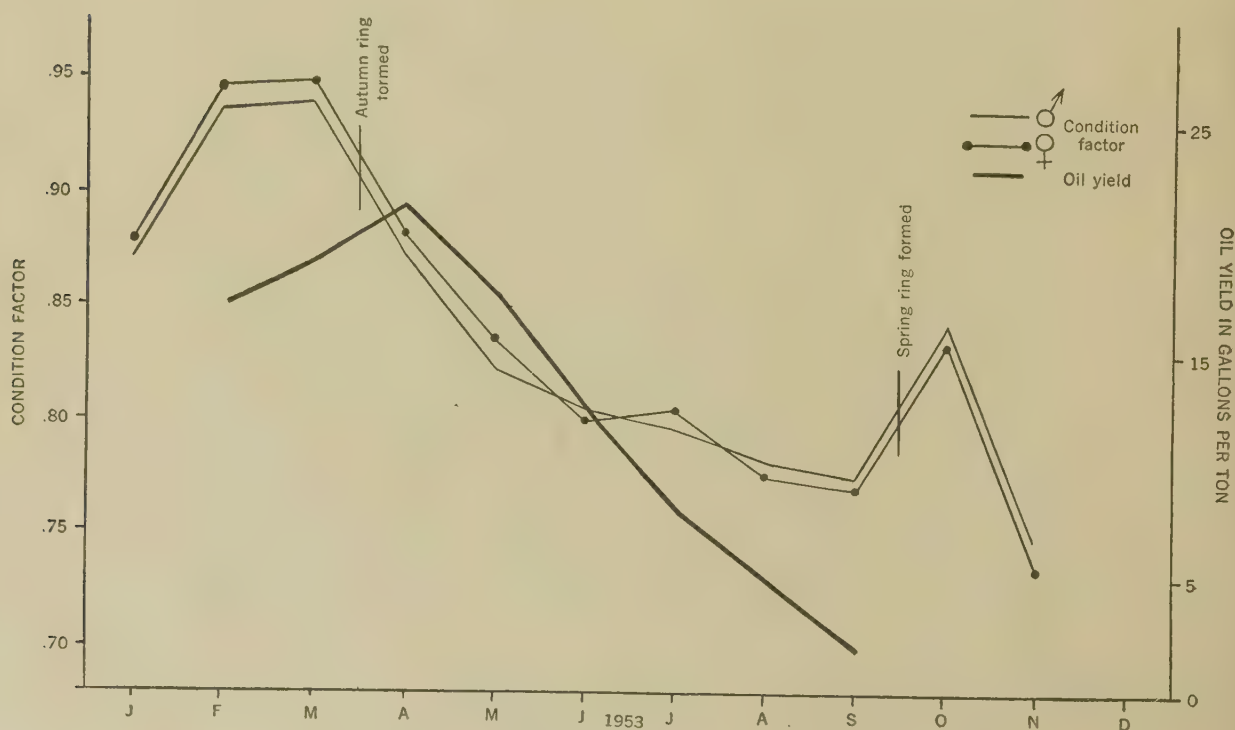


FIG. 5. THE SEASONAL VARIATION OF CONDITION FACTOR AND OIL YIELD FOR ALL FISH.

As far as can be ascertained, rings are formed on pilchard scales twice a year, viz., during autumn and spring. The "autumn ring" is formed in March–April when a very sharp decline in condition factor occurs (see fig. 5) and the "spring ring" is formed six months later in September–October when a sharp rise in condition factor occurs. The "autumn ring", being formed as a result of a sharp falling off of condition, causes a definite break in the growth of the scale and produces a ring of the clear, bold type while the "spring ring" is formed when a sudden increase in condition occurs and produces a comparatively indistinct mark on the scale.

Spawning in the pilchard occurs from September to February so that the first scale-ring formed would be a "spring ring" of the indistinct type.

The data on the ring formation on pilchard scales collected during the years 1950–55 were examined in relation to these possibilities.

5.—AGE COMPOSITION OF THE COMMERCIAL CATCHES.

In this preliminary assessment of the age data collected for pilchards, all intermediate lengths were obtained by means of direct proportion with the aid of the proportion diagram (see fig. 3). Inaccuracies will therefore have occurred as a result of deviations from exact proportionality between scale length and the length of the fish. Since these investigations were concerned entirely with larger fish, the majority of which were sexually mature, it is doubtful whether any serious errors were introduced, particularly as the main deviations from exact proportionality between scale length and total length occur in the juvenile stages not represented in the commercial catches.

Throughout the investigations into the general biology of the South African pilchard, male and female fish were treated separately.

(a) Males.

The mean calculated standard lengths of male pilchards for each scale-ring for the years 1950–55 are shown in Table 1. It is evident from the table that an increase occurred in the total number of scale-rings recorded in the years 1950–55. This should indicate that a successive increase in the maximum age of the commercial catches of pilchards took place. It is felt, however, that the 1950 maximum of only eight scale-rings is a reflection of the difficulties initially encountered in

the reading of the outer-rings of the scales. These difficulties were later to some extent overcome after the biologists concerned had had more experience.

According to these data, the maximum age of male pilchards recorded in the commercial catches in this period was between six and seven years (1955). In the years 1951–54 the maximum ages recorded were between five and six years and in 1950 between four and five years—the latter estimate being extremely doubtful.

Length frequency curves for male pilchards occurring in the commercial catches for the period 1950–55 are included in this report (see Plate 1). The age composition of the important size groups is given in this plate on the basis of the scale-ring data shown in Table 1.

1950.

The commercial catches of male pilchards, during this year ranged from 17.5 cm. to 25 cm. in standard length. This represents a range in age of from two years to an estimated seven to eight years. The dominant size groups for the year were 21.5–23.5 cm., corresponding to ages of from three years to an estimated seven to eight years.

1951.

The length range of male pilchards in the commercial catches during 1951 was 17.5–25.0 cm. corresponding to a range in age of from two years to an estimated seven to eight years. The dominant size groups for the year were 20.5–23.5 cm., corresponding to ages from over three years to an estimated six to seven years.

1952.

The length range of male pilchards in the commercial catches during the year was 17.5–24.5 cm. which corresponded to ages of from two years to an estimated eight years. The dominant size groups for the year were 19.0–23.0 cm., corresponding to ages of from over three years to an estimated six years.

1953.

The length range of male pilchards in the commercial catches during 1953 was 14.5–24.5 cm. which corresponded to ages of from two years to an estimated eight years. The dominant size groups for the year were 20.5–23.0 cm., corresponding to ages of from over four years to an estimated seven years.

1954.

The length range of male pilchards in the commercial catches during 1954 was 19.0-24.0 cm. which corresponded to ages of from three years to an estimated seven to eight years. The dominant size groups for the year were 21.0-23.0 cm., corresponding to ages of from over four years to an estimated six years.

1955.

The length range of male pilchards in the commercial catches during 1955 was 20.0-24.0 cm. which corresponded to ages of from four years to an estimated seven years. The dominant size groups for the year were 21.0-23.0 cm., corresponding to ages of from over four years to an estimated six years.

The following table provides a convenient summary of these age data:—

YEAR.	AGE COMPOSITION OF MALE PILCHARDS IN THE COMMERCIAL CATCHES.	
	All Sizes.	Dominant Size Groups.
	Years.	Years.
1950.....	2-7+	3-6+
1951.....	2-7+	3-6+
1952.....	2-8	3-6
1953.....	2-8	4-7
1954.....	3-7+	4-6
1955.....	4-7	4-6

+ indicates that it is over the one age but has not reached the next age.

During the six years investigated the age of male pilchards in the commercial catches ranged from two year old to eight year old fish. The majority of male fish caught fell within the age groups of three to seven years.

(b) Females.

The mean calculated standard lengths of female pilchards for each scale-ring for the years 1950-55 are shown in Table 2. The successive increase in the total number of rings recorded in the years 1950-55 is, as in the males, more likely to be a reflection of the increasing ability to distinguish the outer scale-rings on the part of the biologists working on age determination rather than an indication of a steady increase in the maximum age of the fish.

Length frequency curves for female pilchards occurring in the commercial catches during the period 1950-55 are shown in Plate 2. The following is an estimate of the age composition of the important size groups based on scale-ring data shown in Table 2.

1950.

The commercial catches of female pilchards during this year covered a range of 18.0-26.0 cm. standard length. This corresponded to a range in age of from under two years to an estimated seven to eight years. The dominant size groups for the year were 22.0-24.5 cm. which corresponded to ages of from just under four years to an estimated six years.

1951.

The length range of female pilchards in 1951 was 17.0-25.5 cm. which corresponded to ages from under three years to an estimated seven to eight years. The dominant size groups for the year were 21.0-24.5 cm. corresponding to ages of from under four years to an estimated seven years.

1952.

The length range of female pilchards during the year was 17.0-25.5 cm. which corresponded to ages of from under three years to an estimated eight years. The dominant size groups for the year were 19.5-24.5 cm., corresponding to ages of from over three years to an estimated seven years.

1953.

The length range of female pilchards in the commercial catches during 1953 was 14.5-25.5 cm. which corresponded to ages of from over two years to an estimated eight years. The dominant size groups for the year were 21.0-24.0 cm., corresponding to ages of from over four years to an estimated seven years.

1954.

The length range of female pilchards in the commercial catches during 1954 was 19.5-25.0 cm. which corresponded to ages of from three years to an estimated six to seven years. The dominant size groups for the year were 21.5-24.0 cm., corresponding to ages of from over four years to five to six years.

1955.

The length range of female pilchards in the commercial catches during 1955 was 20.0-25.0 cm. which corresponded to ages of from four years to an estimated eight years. The dominant size

groups for the year were 21.5-24.0 cm., corresponding to ages of from five years to an estimated seven years.

During the six years investigated the age of female pilchards in the commercial catches ranged from two year old to eight year old fish. The majority of fish caught fell within the age groups of from three to seven years.

As the age composition of the commercial catches of pilchards is almost the same for male and female fish, an approximate combination of ages for the certain specific points on the combined male and female length frequency graphs was made and included on the graphs (see Plate 3).

The following table provides a convenient summary of these age data.

YEAR.	AGE COMPOSITION OF FEMALE PILCHARDS IN THE COMMERCIAL CATCHES.	
	All Sizes.	Dominant Size Groups.
	Years.	Years.
1950.....	2-7+	4-6
1951.....	3-7+	4-7
1952.....	3-8	3-7
1953.....	2-8	4-7
1954.....	3-6+	4-5+
1955.....	4-8	5-7

+ indicates that it is over one age but has not reached the next age.

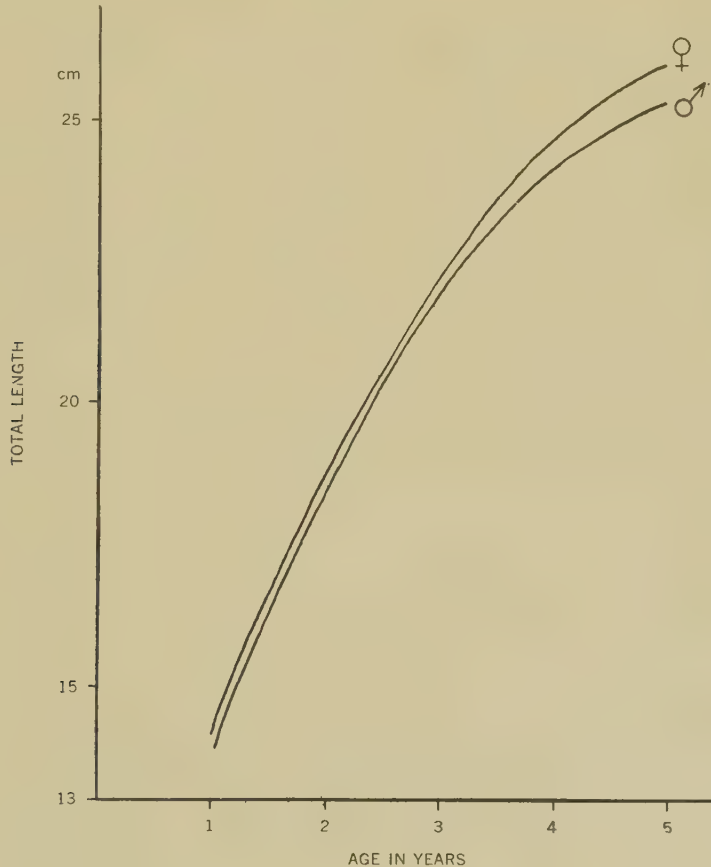


FIG. 6. APPROXIMATE GROWTH RATE CURVES FOR MALE AND FEMALE PILCHARDS FOR THE FIRST FIVE YEARS

On the basis of these investigations it may be tentatively stated that *the ages of the fish comprising the commercial catches of pilchards off the West coast of the Union of South Africa during the period 1950-55 ranged from two to eight years. The majority of fish caught, however, fell within the age groups of from three to seven years.*

6.—RATE OF GROWTH.

Approximate growth-rate curves for male and female pilchards for the first five years were plotted on the basis of the data contained in Tables 1 and

2 (see Fig.6). The curves were not extended to include the sixth year as the calculated lengths at this age are without doubt incorrect since they show a sharp increase in the rate of growth at a time when the growth-rate normally becomes slowed down. This anomaly has no doubt arisen due to the fact that the outermost scale-rings were close together and not clearly defined, thus making accurate identification difficult. A determined attempt should be made in all future age determination studies to interpret the outer scale-rings accurately.

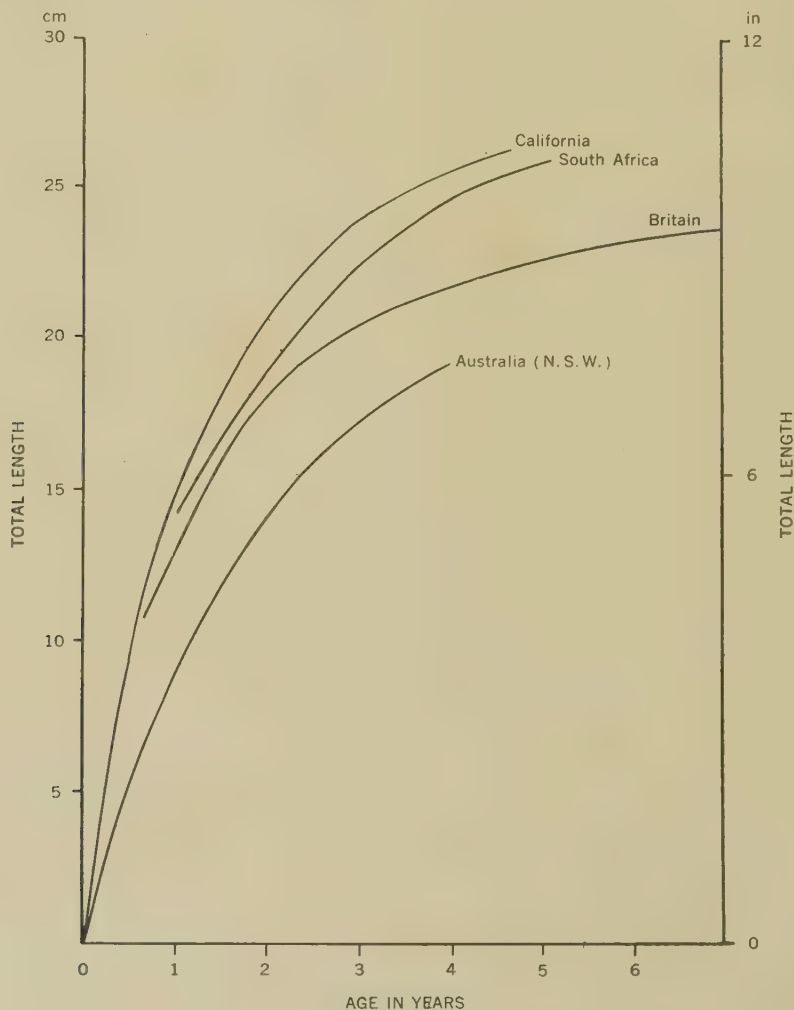


FIG. 7. APPROXIMATE GROWTH RATES OF THE SOUTH AFRICAN PILCHARD THE CALIFORNIA SARDINE, THE BRITISH PILCHARD AND THE AUSTRALIAN PILCHARD

The growth rate curves show clearly that the female pilchard is a larger fish than the male, almost certainly throughout its life.

A mean curve for male and female South African pilchards combined was calculated and plotted on a graph prepared by Blackburn (1949) in order to illustrate the rate of growth of the South African pilchard as compared with closely related species such as the California sardine (*Sardinops caerulea*), the European pilchard (*Sardina pilchardus*) in British waters and the Australian pilchard (*Sardinops neopilchardus*) in New South Wales waters (see Fig. 7).

Although the growth-rates illustrated are approximate, it may be concluded that the growth rate of the pilchard off the West coast of the Union of South Africa is generally rather slower than that of the California sardine but it is more rapid than that of the European pilchard and the pilchard in Japan, in the Atlantic and Mediterranean Oceans and in Australia off New South Wales (see Blackburn, 1949). The growth-curve of the South African pilchard resembles that of the California sardine more than any other species examined.

7.—ACKNOWLEDGMENTS.

I am indebted to Dr. J. M. Marchand, Director of Fisheries and my colleagues at the Division of Fisheries for reading and criticising this paper.

I wish to acknowledge the advice and assistance given in scale reading by Dr. Maurice Blackburn of the University of Hawaii during and after his visit to South Africa in 1950.

I wish further to acknowledge the assistance given in the reading of scales by Messrs. B. de Jager, C. Nepgen, R. van Zyl and A. Heydorn of the Division of Fisheries and Mr. D. van Schoor, late of the Division.

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TABLE 1.

MEAN CALCULATED STANDARD LENGTHS* OF MALE PILCHARDS PER SCALE-RING AND CORRESPONDING AGE GROUP, 1950-55.

No. of Rings.....	1	2	3	4	5	6	7	8	9	10	11	12
Age Group.....		I		II		III		IV		V		VI
Year.—	cm.	cm.	cm.	cm.	cm.	cm.	cm.	cm.	cm.	cm.	cm.	cm.
1950.....	9.9	12.7	15.4	18.0	19.7	20.7	21.0	22.0	—	—	—	—
1951.....	8.4	10.7	12.8	14.9	16.8	18.5	19.9	20.7	21.3	21.8	—	—
1952.....	7.7	9.4	11.6	13.9	16.1	18.0	19.5	20.3	20.6	21.5	—	—
1953.....	7.9	10.0	12.2	13.9	15.4	16.8	18.1	19.3	20.4	21.0	—	—
1954.....	11.1	13.2	15.0	16.5	17.9	19.0	19.8	20.5	21.0	21.4	—	—
1955.....	11.6	13.8	15.0	16.3	17.3	18.1	19.1	19.9	20.7	21.4	22.1	22.7
Mean.....	9.4	11.6	13.7	15.6	17.2	18.5	19.6	20.5	20.8	21.4	22.1	22.7
Corresponding Total Length....	11.1	13.8	16.3	18.5	20.4	21.9	23.2	24.2	24.6	25.3	26.1	26.8

* The lengths given in these tables have not been adjusted for deviations from exact proportionality of scale length to body length and must therefore be regarded as approximations only.

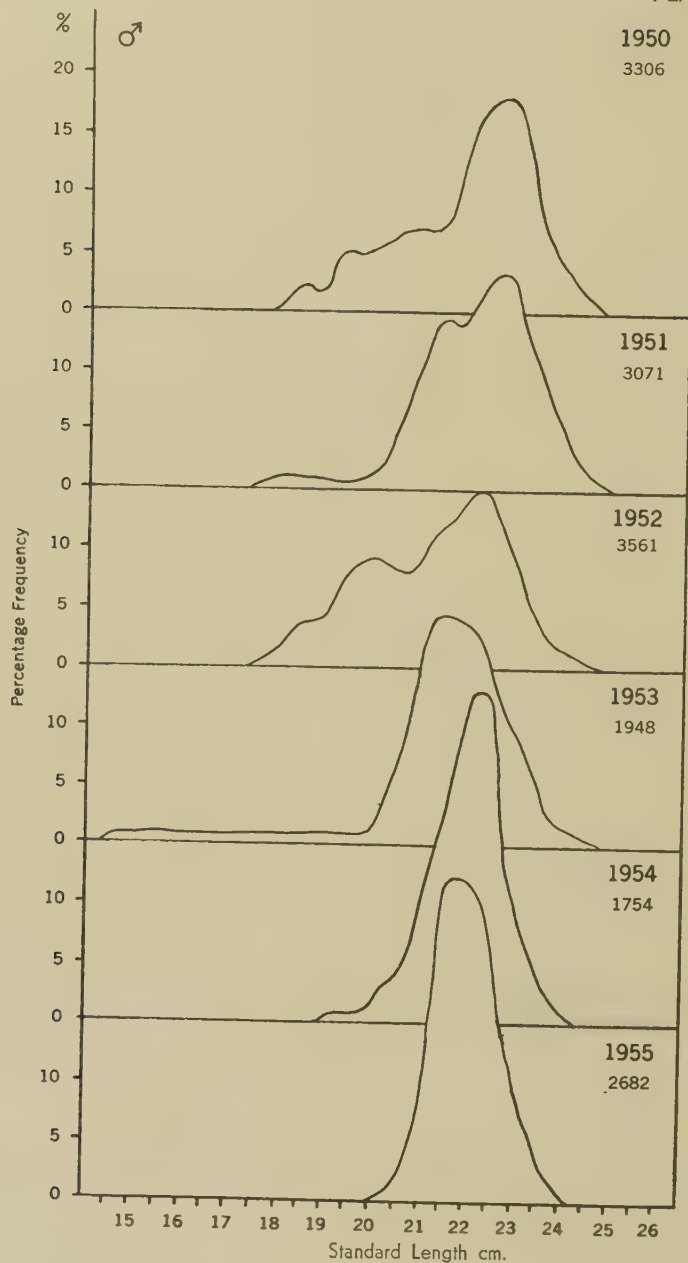
TABLE 2.

MEAN CALCULATED STANDARD LENGTHS* OF FEMALE PILCHARDS PER SCALE-RING AND CORRESPONDING AGE GROUP, 1950-55.

No. of Rings.....	1	2	3	4	5	6	7	8	9	10	11	12
Age Group.....		I		II		III		IV		V		VI
Year,—	cm.	cm.	cm.	cm.	cm.	cm.	cm.	cm.	cm.	cm.	cm.	cm.
1950.....	10.2	13.1	15.9	18.4	20.1	21.4	21.7	22.7	22.9	—	—	—
1951.....	8.5	10.5	12.7	14.9	16.7	18.6	20.1	21.2	21.7	22.6	—	—
1952.....	7.9	9.6	11.7	14.1	16.2	18.3	19.7	20.9	21.7	22.3	—	—
1953.....	8.1	10.1	12.1	13.8	15.4	17.0	18.3	19.5	20.4	21.4	22.3	—
1954.....	11.0	13.4	15.3	16.9	18.2	19.6	20.6	21.3	21.6	22.2	23.5	24.7
1955.....	11.9	13.8	15.2	16.3	17.3	18.1	19.1	19.9	20.7	21.5	22.2	23.0
Mean.....	9.6	11.8	13.8	15.7	17.3	18.8	19.9	20.9	21.5	22.0	23.0	23.9
Corresponding Total Length....	11.4	14.0	16.3	18.6	20.5	22.2	23.5	24.7	25.4	26.0	27.1	28.2

* The lengths given in these tables have not been adjusted for deviations from exact proportionality of scale length to body length and must therefore be regarded as approximations only.

PLATE 1.

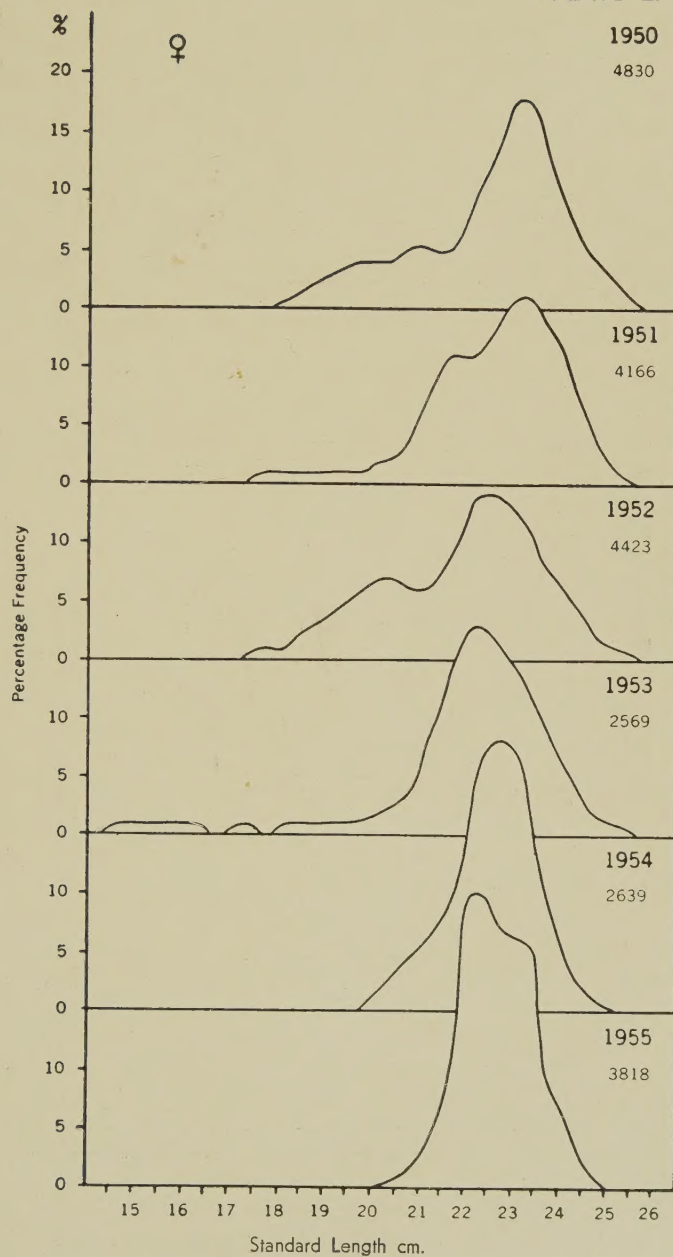


Males

LENGTH FREQUENCIES PER YEAR FOR PILCHARDS, 1950-55

N.B. Figures below years indicate numbers of fish examined.

PLATE 2.

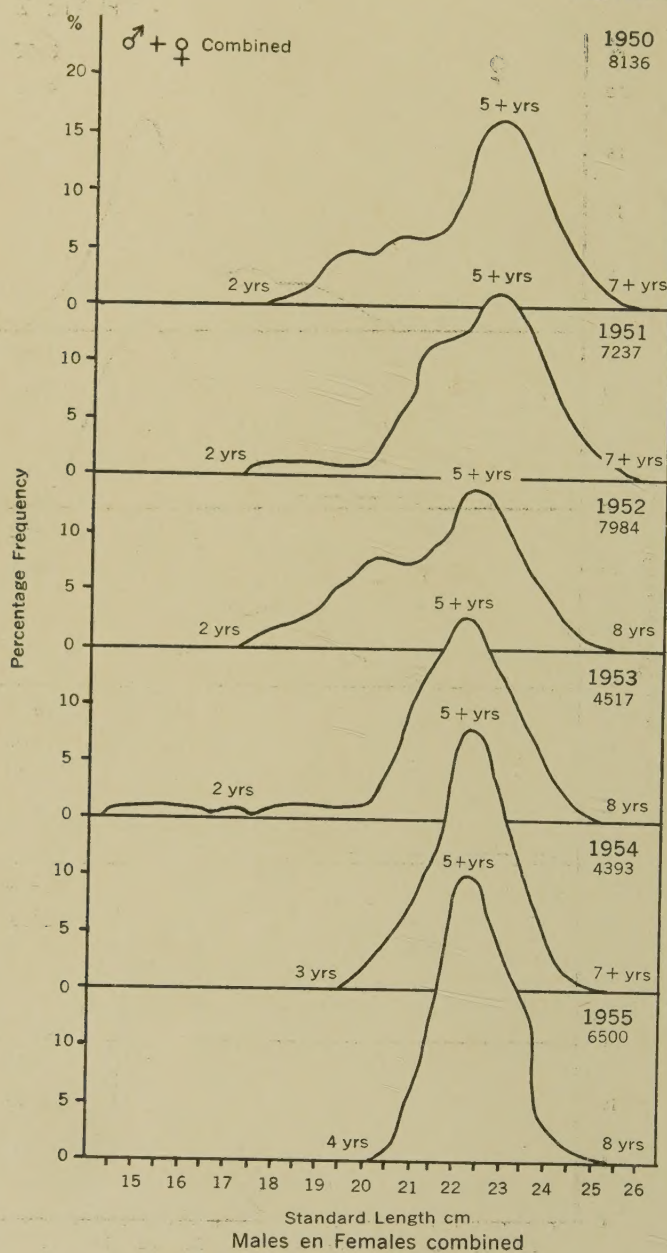


Females

LENGTH FREQUENCIES PER YEAR FOR PILCHARDS, 1950-55

N.B. Figures below years indicate numbers of fish examined.

PLATE 3



LENGTH FREQUENCIES PER YEAR FOR
PILCHARDS TOGETHER WITH APPROXIMATE
AGES, 1950-55

N.B. Figures below years indicate numbers
of fish examined

Trigsurvey, 1957.

Government Printer, 1957.

